APPENDIX A

CA TOOL BRASSBOARD TECHNOLOGY PERFORMANCE REQUIREMENTS

A.1 INTRODUCTION

NASA is currently planning an aggressive program of robotic exploration missions to Mars. The Mars Exploration Program (MEP) is a science-driven, technology-enabled effort to characterize the solid planet and its atmosphere, its geological history, its climate and the processes that may provide insight into climate change on Earth; to determine what resources it might provide for future exploration; and to search for evidence of extinct or extant life on Mars. The MEP missions will also support data collection and technology demonstrations critical to planning and carrying out future missions to Mars. The Mars Technology Program (MTP) provides technology to the Mars missions. This technology announcement for a CA Tool Brassboard is being developed under MTP to be used by future Mars Missions including but not limited to the Mars Science Laboratory 2009 Mission.

A.2 BACKGROUND / MISSION(S) INFORMATION

Information on future NASA Office of Space Science (OSS) Mars Exploration Missions can be found at the URL: http://marsprogram.jpl.nasa.gov/missions/

The overall MSL science objective is to explore and quantitatively assess a local region(s) on the Mars surface as a potential habitat for life, past or present. This mission will use a variety of instruments carried on a rover platform that is expected to remain active for one Mars year.

MSL is envisioned to have a robotic arm (1.5 to 2 m long) that carries tools for abrading to remove outer layer of rock and coring to acquire samples of rock and regolith suitable for scientific evaluation. The corer/abrader tool will be autonomously operated on Mars. It is desired that both of these functions are performed by a single Corer/Abrader tool.

A.3 GENERAL FUNCTIONAL DESCRIPTION AND PERFORMANCE REQUIREMENTS

The Corer/Abrader is expected to be mounted on a turret, along with other tools and science instruments, at the end of a robotic arm. In order to keep the mass and power requirements of the arm within the estimated capabilities of the rover, the Corer/Abrader must not require excessive force to be applied by the arm to hold it in contact with the rock. The Corer/Abrader must operate over angles from vertical down to horizontal to 45˚ up, (in other words operate over any angle 0 to 135 degrees with 0 being the corer pointing vertically down) and not require that the arm provide active control during an abrading or coring process. As a result, it is envisioned that the Corer/Abrader has sufficient internal degrees of freedom that, once placed in nominal preloaded contact with a target no further arm actuation is required for the desired abrading or coring action to be accomplished. It is assumed that, if needed, the Corer/Abrader tool will include provisions for starting the coring or abrading without "walking". Shock isolation must be included to limit the shock and vibration environment experienced at the CA/turret interface to the bounds shown in the table below, with margin.

Table 1
Allowable Vibration Spectrum Mounted Instruments at

Frequency	Qualification test Levels
20 – 100 Hz	5.0 g (zero-to-peak)
100 – 2000 Hz	-6 dB / octave
Sweep rate: 1 octave/minute, with 5 repeated up-sweeps	

This tool will have the following performance when drilling rock whose compressive strength ranges up to and including that of hard, dense basalt

Table 2

Parameter	Relationship	Value, units
Diameter of abraded spot	not less than	3.5 cm
Diameter of core	between	0.8 and 1.2 cm
Max Length of core	between	10 and 12 cm
Mass	less than	4 kg
Peak power use (Abrading)	less than	80 Watts
Peak power use (Coring)	less than	80 Watts
Rate of Penetration (abrading)	at least	5mm/hr
Rate of Penetration (coring)	at least	5cm/hr
Average axial preload force (RMS over any 0.1 s)	less than	80 Newtons
Peak 3-axis reaction force to rigid mount	less than	200 Newtons
Average Reaction Torque (RMS over any 0.1 s)	less than	2 Newton-m
Peak 3-axis reaction torque to rigid mount	less than	4 Newton-m
Maximum lateral force (e.g. when starting hole)	less than	15 Newtons
Operational temperature range at mounting I/F	between	-120C and +35C
Operational atmospheric pressure	Between	1000 -6 millibar air and 6 millibar CO2
Lifetime	at least	75 holes 10 cm deep, 75 abrasion sites
Depth of abraded spot	at least	5mm

Abraded surface quality should be adequate for spectral and optical analysis pending instrument selection. The abrader assembly shall provide a brush to clean abrader during operation and to brush dust from surfaces without abrading. In addition to acquiring a solid core (not powdered) as short as 2cm, and capturing long continuous cores from competent rock, this tool will have the ability to break off cores of hard, dense basalt approximately every 2 cm to the full depth of 10 cm. The corer will also have the ability to retain cores or a core tube filled with loose particulate materials (in any orientation), and the ability to eject/release the core or fine material into a sample-handling device.

The delivered brassboard system must be capable of stand-alone operation (e.g. includes a laptop computer and all operational software needed to validate performance per the above table). CA

Tool operations shall be demonstrated at the temperatures in the above table under Mars ambient atmospheric pressure (6 millibar, GN2) conditions. Electronics are not required to be tolerant of this environment.

Many of the parameters in the above table would be very desirable to improve upon for a flight design - especially mass, preload force, and power (or total time or energy per core). Design options to show how this brassboard would lead to a more optimum flight design are encouraged, but will not be evaluated.

The provider will deliver test data with the brassboard instrument showing the performance of the unit in terms of the parameters in the above tables 1 and 2. The unit will be independently evaluated after delivery by mounting it to a 6-axis load cell attached to a rigid fixture connected to a large block of dense basalt, and the parameters of the above tables will be measured in three orientations (horizontal, coring down and coring up at 45˚). This test will be repeated with softer aggregate rock, and sample retention in dry, loose well sorted sand.